

Forward Scan & 3-D Forward Look Sonars For Ocean Explorer Auv's

Joseph Cuschieri
Lester R. LeBlanc
Department of Ocean Engineering
Florida Atlantic University
Boca Raton, FL 33431-0991
phone: (954) 924-7238 fax: (954) 924-7233 email: joe@jmc.oe.fau.edu
Award #: N000149615012

LONG-TERM GOALS

The long-term goal of this research is to develop Forward Looking Sonar Systems (FLSS) for the Ocean Explorer class and mini class AUV's with specific emphasis on operation in a shallow water environment. [1, 2] The two sonar systems generate different types of seafloor images, one is a Forward Scan Sonar, (FSS) that generates a scan image and the second is a 3-D Forward Look Sonar (3-D FLS) that generates a 3-D rendition of the sea floor terrain. The FSS acquires a complete beamformed image of the seafloor ahead of the AUV at a very fast image rate (4 to 5 full forward sector images per second) providing the information needed for obstacle avoidance, navigation [3], mine recognition and terrain mapping. The 3-D FLS generates images at a slower rate but can be very effective in target recognition. Both a low frequency (250 kHz) and high frequency (600 kHz) versions are being developed.

OBJECTIVES

Our scientific objectives is to develop the technology for developing high resolution, highly capable forward looking sonar systems to be used as payload on Ocean Explorer class and mini class AUV's, for use in the shallow water environment. The technology requirement to support these projects includes the development of the underlying signal processing approaches, data acquisition hardware, data acquisition and processing software implementation, sonar transducer development and power management approaches to facilitate the use of the forward look sonars on battery powered AUV's. Furthermore, other objectives include the development of image processing techniques for target identification, classification, and recognition, and for feature based navigation.

APPROACH

The approach being used in the development of these sonars is based on matched field processing and simultaneous multiple beam forming to achieve high resolution images within a forward sector of view at a fast image refresh rate. The current development systems are based on a 10% to 20% bandwidth projector that insonifies the whole sector of view. The receive hydrophone is a 64 element array where each element of the array is individually received and sampled. This is required for the simultaneous beamforming.

Because of the need for the 64 channels of data acquisition, custom data acquisition cards with a PCI interface have been developed. These cards have 16 channels of data acquisition with direct digital

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filtering and decimation to minimize data bandwidth requirements. Using the PCI interface these cards have potential for other applications since this interface makes them readily integrated with standard PC systems. The rest of the acquisition and processing hardware consist of off the shelf components. The developed hardware interfaces to the power and control (through a Lontalk interface) of the OEX class and mini class AUV's.

For the FS sonar (FSS) two versions are being developed, one based on a 250 kHz center frequency and the other based on a 550 kHz center frequency. The 3-D FL sonar (FLS) is based on the 250 kHz center frequency. Both sonars use the same data acquisition and processing hardware and the same hydrophone receiver. They do however have a different sonar projector.

An additional component of the work in this project is the development of a low cost version of the forward look sonar.

WORK COMPLETED

In this last year multiple mission have been conducted. One of these missions was over mine like targets. The data from these missions is being analyzed to better understand the parameters that control the quality of the images and thus improve the overall operation of the FS and 3-D FL sonars.

Also, in this last year a new combined sonar projector and hydrophone receiver transducer have been designed. This new transducer has three rows of 64 elements array in close proximity. It is envisioned that this transducer can be used for bathymetric scan images, which should enhance the envisioned application for this sonar including feature-based navigation, and target identification and classification.

Finally, the task of design the second version of the data acquisition hardware, the one that has the capability to operate at a maximum frequency of 600 kHz has been completed. The card design is ready to be released for fabrication, which will take place as soon as the continuation funds for this project become available.

We have also started work to commercialize the FSS technology, and developed small-scale (8 channels) low cost low-resolution version for application in the recreational boat industry. In doing this work we have come up with solutions that improve the efficiency of our approach in the use of power and hardware.

RESULTS

The results for the past year can be summarized as follows:

- Revision C of the hardware has been completed and implemented.
- Multiple missions have been conducted successfully, one over a mine-like target area
- A new projector/receiver has been design that can be used in the future for bathymetric forward scan images.
- A mission has been run with the 3-D FL sonar
- Version 2 of the data acquisition hardware that can operates at the higher maximum frequency of 600 kHz has been completed

- A low cost low-resolution commercial version based on the technology developed in this project has been design and ready for transition to the commercial market.

TRANSITIONS

The FSS is being transition to a commercial company to produce a low cost forward look sonar system for use in low cost AUV and small to medium recreational boats. All the development for this transition has been performed and it is estimated that a low-resolution (8 beam) system can be developed for under \$1,000. Interphase Technologies, Inc. is currently interested in this technology transition and are pursuing a licensing agreement with the University.

RELATED PROJECTS

This project is connected with a number of other ongoing projects. The hardware for the data acquisition and processing developed for these forward look sonars is the same hardware being used for the coherent path beamformer acoustic communication project [4]. The project uses these capabilities of the hardware developed here to identify the strongest coherent path for the acoustic communication data. Another project that is related to this one is the development of a high-resolution transducer by MSI under an SBIR funding. The new transducer made from piezocomposites will be conformal to the shape of the mini AUV for improved sonar image quality and optimal hydrodynamic performance of the AUV.

REFERENCES

J. M. Cuschieri, L. LeBlanc, "Forward Look Sonars for Applications on AUV's", Oceanology International Conference and Exhibition, Vol. 2, 307-314, Brighton, UK, March 1998.

J. M. Cuschieri, L. LeBlanc, "A forward Look Sonar for Ocean Explorer Class AUV's", Third International Symposium Technology and the Mine Problem, Monterey California, April 1998.

J. M. Cuschieri, S. Negahdaripour, "Use of Forward Scan Sonar Images for Positioning and Navigation by an AUV", IEEE Oceans '98 Conference, Nice France, September 1998.

Lester R LeBlanc, and J. M. Cuschieri, M. Singer, and , P. P. Beaujean, 'Characterization of the Underwater Acoustic Channel', Proceedings of the IEEE Oceans, Sept., 1996